FOREST PEST MANAGEMENT
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BIOLOGICAL EVALUATION OF PEST CONDITIONS IN DEVELOPED RECREATION SITES, WHISKEYTOWN UNIT, WHISKEYTOWN-SHASTA-TRINITY NATIONAL RECREATION AREA

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ABSTRACT

Recreation sites at the Whiskeytown Unit of the Whiskeytown-Shasta-Trinity National Recreation Area were evaluated for insect and disease pests affecting vegetation. Pest damage was minimal. Overstocking of knobcone pine, leading to scattered mortality, and hazard trees were of concern in some areas. Management alternatives, including the development of site-specific vegetation management plans, are discussed. Pest-specific management actions for annosus root disease, dwarf mistletoe, hazardous tree management, and bark and engraver beetles are presented.

INTRODUCTION

On November 16, 1987, Gregg DeNitto and John Kliejunas, plant pathologists, and Bruce Roettgering and David Schultz, entomologists, from State and Private Forestry - Forest Pest Management, USDA Forest Service, met with Bud Ivey from the Whiskeytown Unit, Whiskeytown-Shasta-Trinity National Recreation Area, USDI National Park Service. The purpose of the meeting was to discuss the objectives and strategy for completing a biological evaluation of developed recreation sites in the Unit. The evaluation was being done at the request of the Regional Director, Western Region, NPS. Field work was completed on November 17-18, 1987.

Two broad objectives were defined for the evaluation:

1) To determine what insect and disease pests were present on, or could affect, the vegetation in developed recreation sites and what management

actions are available to deal with these pests and associated site and stand conditions.

2) To determine the adequacy of the sites for a proposed NPS-sponsored vegetation management training course, as far as pest damage, symptoms, and discussion.

The purpose of this report is to address the first objective.

Observations are discussed separately for each recreation site. Because of the similarity of many of the problems, the management alternatives are presented for the Unit and, in general, are applicable in most situations. Where certain areas had specific problems, these are identified in the observations and applicable management directions are presented there. Maps of each area with locations and descriptions of observed pest organisms and situations are included at the end of this report.

OBSERVATIONS/DISCUSSION

Clear Creek National Environmental Education Development Camp (N.E.E.D.)

The vegetation around this camp includes native and introduced tree species. Native species are California black oak, canyon live oak, Digger pine, ponderosa pine, redbud, willow, and bigleaf maple. The main introduced species are black locust, sycamore, ash, and purple plum. The facilities are dispersed among this tree vegetation, with occasional grassy areas. The most common tree species in the camp is the live oaks the camp abuts an oak woodland on the southwest side where student cabins are located. The rest of the camp is on a flat with scattered trees, except where plantings have increased tree density.

A number of trees were observed that should be evaluated more closely for hazard potential. Defects that were seen included decay, forks, and leans. As a group, the oaks had the most problems. Implementation of a hazard tree management program (described later) should be considered for this camp, especially around the student cabins.

Pest organisms that were observed included sequoia pitch moth (Vespamima sequoiae) associated with pruning wounds on ponderosa pine, true mistletoe (Phoradendron villosum ssp. villosum) on oaks, and white trunk rot (Phellinus robiniae) of black locust. None of these organisms were causing significant damage.

Two other observations were made of factors that could influence the vegetation in this camp. Stand density is high in the planted ponderosa pine along the south side of the specimen pond. The density should be managed at reasonable levels to minimize undesired mortality. Although measurements of site quality and stand density were not taken, this site is at a low elevation for ponderosa pine and likely does not maintain adequate soil moisture to support a high density. This may be mitigated somewhat by the proximity of the pond. Suggested stocking for this aggregation is around 150 sq. ft./ac. of basal area. The second observation is the number of exotic trees planted in the camp. Future revegetation efforts should avoid exotics. Stock for planting

should be native to the site and should preferably come from seed from nearby stands.

Carr Power House Picnic Area

This area is primarily grass with introduced sycamores, honey locusts, and black locusts. No pests were observed in these trees. In the knobcone pines along the road near the entrance, dwarf mistletoe (probably Arceuthobium campylopodum) was seen. Significant damage from this parasite was not observed, but it may intensify and spread, eventually causing scattered mortality of the knobcone pine.

Tower House

This former home site is surrounded by lawn, fruit trees, and exotic plantings. Three groups of dead trees were present, including incense-cedar, Douglas-fir, and hardwoods. No primary pests were observed, but none of the trees were planted in their native habitat. Environmental stresses associated with this off-site planting were primary factors in tree mortality. Gopher (Thomomys sp.) mounds were common in the lawn and any regeneration efforts could be seriously hampered by pocket gophers. A large branch had broken out of a willow near the water tank. Tree failures could be a problem in this area as the trees age and if visitor usage is encouraged.

Oak Bottom Recreation Area

This recreation area consists of a developed campground, beach, marina, and picnic area. The principal tree species in all of the areas is knobcone pine. Others include canyon live oak and California black oak. The knobcone pine stands appear to be even-aged with a canopy closure of 60-80%. Beneath these trees is a dense stand of brush, principally manzanita. Other brush species are chamise and toyon.

Several small groups of dead knobcone pine were observed. One group near site 3 in the campground had been attacked by pine engraver beetles (Ips sp.) and red turpentine beetles (Dendroctonus valens). These trees were in a dense stand on a ridge with a heavy brush component. Other dead knobcone pines had evidence of California flatheaded borer (Melanophila californica). These insects tend to attack stressed trees where soil moisture is limited.

Manzanita were seen with branch and twig dieback in much of the area, especially around the amphitheater. The dieback was associated with Botryosphaeria canker. This dieback does not appear to be adversely affecting the manzanita.

The principal concern in this area that could affect pest conditions is the high stocking and dense brush. Knobcone pine will be a difficult species to manage over the long-term. It is a short-lived species that naturally grows in dense, even-aged stands. It does not readily regenerate itself, except following fire. Appropriate growing stock levels that will keep mortality at acceptable levels are not known, but can be estimated. The ability of this area to be managed as a recreation site with similar vegetative conditions in the long-term (2 or more decades) is uncertain.

Whiskey Creek Group Picnic Area

This area is occupied by a dense knobcone pine stand, with some ponderosa pine and oaks. The stand is even-aged with 50-70% canopy closure. Brush species other than grass and manzanita are not a major component.

No biotic pests were observed. The principal pest management concern is the overstocking and associated stress. Thinning this stand would be the most beneficial action. Future management actions should consider the need for regeneration and what efforts will accomplish it.

Dry Creek Group Camping Area

This camping area is on a knoll that extends into Whiskeytown Lake. It is covered mainly by a black oak stand. This stand arose as stump sprouts following apparent harvest activities. The present stand is dense with 80% or more crown cover and numerous sprouts per stump. In addition to the black oak, there are some live oaks and ponderosa and knobcone pines.

Minor infections of true mistletoe (P. villosum ssp. villosum) are present on the oaks. Although the level of infection may increase with time, it is not expected that this parasite will increase substantially in this stand and cause significant damage, if management actions are taken to promote stand vigor. North of the entrance to the campground, dwarf mistletoe (A. campylopodum) is present in knobcone and ponderosa pines. Infection levels are light and the extent of the infestation is limited. Little, if any, damage is presently occurring. In the surrounding areas where knobcone and ponderosa pines are contiguous, the dwarf mistletoe may spread and intensify. However, because of the small proportion and generally scattered nature of the pines in this stand, spread will be restricted. Where allowed to intensify in individual trees, dwarf mistletoe may increase the tree's susceptibility to successful bark beetle attacks, leading to tree mortality.

The remaining concern in Dry Creek group camp was the hazard potential. Many of the oak sprouts originated from old stumps and may be attached to the stump above the root collar. These connections tend to be weak, with decay moving readily from the stump into the sprout. Because of their branching pattern, oaks also tend to lose limbs more readily. In the knobcone pines, a heartrotting organism, Phellinus pini, was seen fruiting on the boles of some trees. Although just the presence of the fruiting body does not indicate a high failure potential, infected trees could suffer stem breakage, especially if other factors, such as interacting defects or high winds, are involved.

Brandy Creek Recreation Area

This large recreation area includes a marina, camping area, picnic area, and beach. These recreation facilities are dispersed in a forest stand with interconnecting foot trails. There is both a concentrated and dispersed type of recreation in the area. We examined trees in the vicinity of capital improvements and where concentrations of people are likely to occur. We also walked the trails and made observations of the vegetation in the near vicinity.

These stands are the most mixed in terms of species and size of all that we examined. Knobcone pine is the primary species, but ponderosa pine, black oak,

and live oak are commonly scattered throughout. Even though tree sizes vary, aggregations are even-aged and one-storied stands are typical. Stand density also varies between aggregations, but overstocking appears to be the prevailing condition.

A number of pest organisms were observed in this recreation area. In the vicinity of the trailers at the marina, an annosus root disease center (Heterobasidion annosum) was discovered. There was a knobcone pine that had been attacked and killed by flatheaded borers in 1986. Nearby was a recently killed knobcone pine sapling. This disease center was still small and no surrounding conifers had above ground symptoms of infection. Two pockets of dwarf mistletoe were present in the knobcone pine in the camping area. Infection levels were slight in both pockets and the pathogen did not appear to be significantly affecting the trees. However, without treatment the dwarf mistletoe will spread into surrounding trees and intensify, leading eventually to tree mortality. True mistletoe was seen in some black oaks adjacent to the marina parking lot. Branch galls of western gall rust (Endocronartium harknessii) were on some knobcone pine in the camping area. Some knobcone pines had conks of P. pini along their bole.

A significant concern in the area was potentially hazardous trees. A number of categories of defects were observed. Recently killed and older dead trees were present, mainly along trails and areas of dispersed recreation. Tree hollows from decay and wounds were witnessed. Forking, leaning, and weak branching patterns were seen in the oaks. As in the other recreation areas, a tree hazard management plan that goes beyond dead tree removal may be advisable.

The other concern that is applicable to most of the recreation areas is stand density. Overstocking is a common problem and is reflected in the scattered mortality. Near the water station in the camping area, larger amounts of knobcone pine mortality have occurred over the past decade. No pests other than flatheaded borers and turpentine beetles were present. Prior to the tree mortality, stocking levels were high in this aggregation. Other interacting stress factors at this particular site were aspect and tree size. Trees were on a hot, dry, southwest-facing slope which would have contributed to moisture stress. The dead trees were large for knobcone pine ($\geq$ 20 inches dbh) and indicative of advanced tree age for the species. Because of the short-lived nature of knobcone pine, this advanced age was another stress factor. Comparison of the radial growth over the past five years of a recently dead knobcone pine and an adjacent live knobcone pine revealed a considerable decline before tree death.

MANAGEMENT ALTERNATIVES

1. NO ACTION. Vegetation management to benefit the long-term conditions of these recreation areas would not be accomplished. The trees would continue to grow in their present condition and losses would occur because of the absence of vegetation management. Tree mortality will occur periodically in the recreation areas. The amount of mortality will vary with the site, species of trees on the site, and environmental conditions. Mortality of the principal pine species present, knobcone pine, will likely be a result of attacks by pine engraver beetles, probably in conjunction with other cambium-feeding insects.

The oaks may succumb more slowly, with individual branch dieback and eventual tree mortality.

Pine mortality may occur as individual trees, or as groups of 2-3 trees. In addition to tree mortality, top-killing may also occur. Both mortality and top-killing will likely increase during and immediately following drought years, and can be expected to be heaviest in stands with dense stocking or in stands under severe competition with brush.

There is the potential for property damage or human injury when hazardous trees fail.

2. VEGETATION MANAGEMENT. This alternative requires the development of vegetation management plans for each of the areas. Development of such plans requires that long-term objectives be established. These objectives would include the desired future condition and appearance of the vegetation in each area. Vegetation management is a long-term commitment and cannot be accomplished through one-time events. Topics to be considered in such plans include species composition, stocking levels, desired brush species, pest management actions, and need for regeneration. For some sites, desired future conditions may not be achievable with the existing conditions. In these situations, sites and facilities may need to be relocated to more suitable sites where the long-term conditions can be achieved.

PEST-SPECIFIC MANAGEMENT ACTIONS

1. ANNOSUS ROOT DISEASE. Annosus root disease is at very low levels at present. To maintain this situation, prevention provides the best opportunity and is easily accomplished. The application of borax (sodium tetraborate decahydrate, EPA Reg. No. 1624-94) to conifer stumps immediately after trees are cut is the most effective method to prevent infection by the fungus.

2. DWARF MISTLETOE. Dwarf mistletoe is limited to the Carr Power House picnic area and Dry Creek camping area. The infestations in both areas are on the edge of the recreation sites and are limited in occurrence. Neither infestation is causing significant impact at present, but they could slowly spread into the trees in the recreation areas and intensify. As the mistletoe infections intensify in trees, stress would be increased and the trees would increase in their susceptibility to bark beetle attacks.

Because of the limited infestation, treatments to reduce the risk of further spread of the parasite could be easily implemented. Removal of infected trees is a direct method of dealing with dwarf mistletoe. In situations where it is desired to retain individual infected trees, pruning infected branches can be effective if at least a 30% live crown ratio exists after treatment. Eradication of dwarf mistletoe from around the recreation areas is a simple long-term solution. If this isn't possible, then spread of the infection into the recreation areas can be stopped by creating a buffer around them. This usually means removing host trees and encouraging the growth of non-hosts. The width of such a buffer strip in the stands we observed would be 50 feet.

3. HAZARDOUS TREE MANAGEMENT. A hazardous tree management program would be initiated in the recreation complex with the objective of reducing the number

of tree hazards to an acceptable level, thereby reducing the probability of damage of property and risk to public safety. Such a program would require an initial inspection to determine the locations of hazardous trees and to prescribe any actions necessary to reduce the hazard. In most cases, this would be tree removal, but other measures, such as topping, pruning, bracing, and relocating improvements, may be appropriate depending on the specific situation. This inspection and any actions taken should be documented.

Once initiated in an area, a hazardous tree management program should be a continuous process with periodic reinspections and subsequent actions, when necessary. These activities should be documented, both for legal purposes and for determining if changes in hazard are occurring in individual trees.

Because of the large area and number of facilities involved, a hazardous tree management program could be initiated in various parts of the complex over time. This would require prioritizing areas for treatment. Two criteria from strictly a hazard reduction consideration should be used in establishing these priorities. The amount of defect and its likelihood of resulting in failure should be considered. Areas with considerable decay, dead tops, and leaning trees would have a high priority. The second consideration should be toward the amount of damage that could result if failures did occur. Tree size is an important character involved since larger trees have a larger target area and the resultant damage may be greater. Also, the value of the targets may influence the priority for treatment.

The results of a hazardous tree management program on the vegetative characteristics in the recreation area will depend on the levels of hazard deemed acceptable and the intensity of activity undertaken. An active program in many areas of the complex could result in a substantial loss of tree cover because of the number of hazardous trees. A greater vegetative component could be retained, at least for the short-term, by being conservative in selecting trees for removal for hazard reduction.

4. BARK AND ENGRAVER BEETLES. Knobcone pine is an early seral species which regenerates only after fire. It can persist to ages over 125 years, but only as isolated trees or in open park-like groves. It will grow rapidly at younger ages but generally matures and stagnates at some time between 45 and 75 years of age if untreated. Bark and engraver beetles will kill groups of trees in stagnated stands. Under natural conditions, groups of dead trees would increase the probability of wildfire which would tend to regenerate the stands. Because natural processes are not operating in the campgrounds, knobcone pine will not regenerate itself and it would take a considerable investment of time and money just to prolong the lives of some of the existing knobcone pines.

A. Thinning. Thinning offers a fairly long-term (10 years or more) way of reducing the risk of bark or engraver beetle attacks on the knobcone pine. While specific figures not available, an extrapolation from other sites and species suggest that a level of 100-120 square feet/acre basal area of all woody species would be appropriate, if there is no other competition from brush or grass. If brush is intentionally left for screening or other purposes, a lower basal area of trees should be retained. Oaks or other well formed hardwoods may have a higher long-term value in recreation areas than

knobcone pine, so it may be preferable to retain them when choices are made during thinning.

The trees will grow and add basal area as they age. The benefits of thinning will diminish with time and some additional thinning should be planned at about 10-year intervals to maintain healthy stands. When any live or recently dead conifers are cut in developed sites, the stumps should be treated with borax to prevent infection by annosus root disease. All green pine slash created during thinning or other work which is over three inches diameter should be treated to make it unsuitable for breeding by pine engravers, Ips spp. The most thorough means of modifying the slash is the use of a chipper. Chipping tends to be somewhat expensive, but the expense can be partially offset if the chips are considered valuable on the site to mitigate the effects of soil erosion or compaction. The other methods of slash modification which tend to be acceptable in recreation areas are to completely remove all green pine stems and branches over 3 inches diameter from the site or to move them at least 1/4 mile from the nearest pine tree which is intended to be retained.

B. Protective Insecticide Treatment. Two formulations of carbaryl insecticide (Sevin 50W and Sevin 80S) are registered for use on pines to prevent attacks by bark and engraver beetles. A single application to the main stem by hydraulic sprayer from the ground will prevent most attacks for up to a year. If the insecticide is applied in response to a temporary, reversible stress, such as drought or construction disturbance, it could be considered a logical part of an integrated pest management program.

BIOLOGIES OF PEST ORGANISMS

CALIFORNIA FLATHEADED BORER. The California flatheaded borer, Melanophila californica, principally attacks Jeffrey and ponderosa pines, although it may be found in other pines.

It is most severe in stands located on sites where environmental stress is common. Decadent or unhealthy trees are most frequently attacked, along with an occasional top of a thrifty, vigorous tree.

Eggs are laid in bark crevices of the host tree. Newly hatched larvae penetrate directly through the bark to the phloem. Here the larvae may feed from a few months to 4 years without any apparent effect on the host tree. Should host vigor and larval abundance not allow them to succeed, the larvae cut very short galleries before they die. These galleries do not seriously injure the tree and are overgrown by the cambium. Should conditions be, or become, favorable for the larvae and unfavorable for the tree, the larvae develop rapidly and destroy the cambium.

Although this insect can kill trees weakened by dwarf mistletoe and root disease, its primary importance is rendering trees increasingly susceptible to bark beetles.

RED TURPENTINE BEETLE. The red turpentine beetle, Dendroctonus valens, occurs throughout California and can breed in all species of pines. It normally attacks injured, weakened or dying trees and freshly cut stumps. The adults are

attracted by fresh pine resin. They often attack wounded trees in campgrounds or following logging, trees scorched by wildfire or prescribed burns, lightning-struck trees and root-diseased trees exhibiting resinosis.

Attacks usually occur at the soil line or root crown and are characterized by a large reddish pitch tube at the point of entry. On severely stressed trees or during periods of drought, attacks may occur underground on the main roots up to 15 feet from the bole and also on the bole to a height of 10 feet. If an attack is successful, the adults excavate an irregular gallery in the cambium and the female lays eggs along the sides. The larvae feed in a mass and destroy an area of cambium ranging from 0.1 to 1.0 square feet. Attacks do not always kill trees but may predispose them to attack by other bark beetles. Repeated or extensive attacks by the red turpentine beetle can kill pines.

Attacks occur throughout warm weather and peak at mid-summer. The number of generations varies from two years for a single generation at the coldest portions of its range to two or three per year in the warmest.

PINE ENGRAVER BEETLES

Pine engraver, Ips spp., attacks have been recorded on most species of pines in California. These beetles kill saplings, poles and sawtimber up to about 26 inches dbh and the tops of even larger trees. Attacks on live trees are usually limited to trees which are suppressed, or stressed by dwarf mistletoe, root disease, drought, fire or the attack of other insects. If fresh slash is available in the spring, pine engravers may build up in an area and cause localized mortality or top killing by mid-summer.

Attacks are made with the coming of warm weather in the spring. Attacking males bore nuptial chambers in the inner bark and release a pheromone which attracts other beetles to the attack site. If many beetles are attracted, they may attack nearby trees and cause a group kill. Within a day or two of the attack by the male, two to five females enter the nuptial chamber and after mating, each female bores an individual egg gallery which lightly scores the sapwood. The size and pattern of the combined gallery pattern is often diagnostic of the species of Ips involved. The galleries are kept open by beetles pushing boring dust out through the entrance hole. Red boring dust collecting in bark crevices or spider webs is diagnostic of a successful attack. Eggs are laid in niches along the sides of the galleries. Larvae hatch from the eggs and feed in the phloem. They eventually pupate in cells at the end of their larval mines and transform to adults.

A new generation is produced in as little as 6-8 weeks in the spring to 4-6 weeks in mid-summer (August). Thus, several overlapping generations per year may be produced. The winter may be passed in any of the life stages of larvae, pupae, or adults, depending upon which Ips species is involved.

Outbreaks in standing, healthy trees are sporadic and of short duration, and are often associated with some temporary stress or shock afflicting the host species, such as drought or logging disturbance. Tree killing frequently occurs where green pine slash, which serves as breeding habitat is left untreated during spring and summer. To be suitable as pine engraver breeding habitat, pine slash must have bark from 1/8 to 1 inch thick (usually 3 to 26

inches diameter), must have succulent cambium and must remain moderately cool during the development period.

WESTERN DWARF MISTLETOE. Dwarf mistletoes (Arceuthobium spp.) are parasitic, flowering plants that can only survive on living conifers in the Pinaceae. They obtain most of their nutrients and all of their water and minerals from their hosts. Western dwarf mistletoe (A. campylopodum) infects principally ponderosa, Jeffrey, and knobcone pines, and occasionally Coulter and lodgepole pines.

Dwarf mistletoes spread by means of seed. In the fall the fruit ripen and fall from the aerial shoots. The seeds are forcibly discharged. The seed is covered with a sticky substance and adheres to whatever it contacts. When a seed lands in a host tree crown, it usually sticks to a needle or twig, where it remains throughout the winter. The following spring the seed germinates and penetrates the twig at the base of the needle. For the next 2-4 years, the parasite grows within the host tissues, developing a root-like system within the inner bark and outer sapwood, and causing the twig or branch to swell. Aerial shoots then develop and bear seed in another 2-4 years.

Dispersal of dwarf mistletoe seeds is limited to the distance the seeds travel after being discharged. From overstory to understory, this is usually 20 to 60 feet, but wind may carry them as far as 100 feet from the source. A rule of thumb is that the seeds can travel a horizontal distance equal to the height of the highest plant in an infected tree. There is some evidence that long distance spread of dwarf mistletoe is occasionaly vectored by birds and animals. Vertical spread within tree crowns of most dwarf mistletoes is limited to less than one foot per year because of foliage density.

Dwarf mistletoes are easy to identify because they are generally exposed to view within a tree's crown. Signs of infection include the yellow-green to orange mistletoe plants, basal cups on a branch or stem where the plants were attached, and detached plants on the ground beneath an infected tree. Symptoms include spindle-shaped branch swellings, witches' brooms in the lower crown, and bole swellings.

ANNOSUS ROOT DISEASE. Heterobasidion annosum is a fungus that attacks a wide range of woody plants, causing a decay of the roots and lower bole and death of sapwood and cambium. All pines in California are susceptible; hardwoods are rarely affected.

The fungus becomes established in freshly cut stumps from air-borne spores produced by fruiting bodies (conks). It then grows into the root system and may spread to adjacent healthy trees via root contacts. Infected pines are usually killed rather rapidly when H. annosum girdles the root collar. After a suitable period of time, conks are produced under the bark of dead trees, in decayed stumps, or in the duff at the root collar.

Local spread of H. annosum through roots results in the formation of disease centers that have dead trees in the middle and dying trees on the margin. These centers usually continue to enlarge until they reach barriers such as openings or groups of non-host plants. The fungus may remain alive for as long as 50 years as a saprophyte in infected roots and stumps. Pines may seed in or

be planted in centers and survive for a few years, but they eventually will be infected and die.

RED RING ROT. Red ring rot, also called white pocket rot, is caused by a wood decay fungus, Phellinus (Fomes) pini, that attacks Douglas-firs, pines, true firs, hemlock, and rarely incense-cedar. It occurs throughout the coniferous forests of the world, and is the single most damaging heart rot organism in the West.

Red ring rot attacks young-growth as well as old-growth trees. It usually infects through branch stubs, and rarely through open wounds. Thus, this fungus may cause serious heart rot problems in managed stands of the future.

The perennial, woody fruiting bodies or conks that arise from the branch stubs or knots of living trees are the best indicators of decay. Sometimes only punky knots bearing the inner portion of the fruiting body remain on the stem. These punky knots may later be overgrown by new wood, becoming swollen knots that are the only symptom of decay. When conks or swollen knots are present, assume that advanced decay extends about 3-5 feet above and 5-7 feet below the indicator. If conks or swollen knots are visible along much of the stem, heart rot will be extensive.

POCKET GOPHER. The pocket gopher, Thomomys bottae, is a rodent in the family Geomyidae. They spend most of their life in an extensive tunnel system. The surface openings to their tunnel system are kept well-plugged except while burrowing, gathering food a few inches around feed holes, or sometimes following rains. They are highly solitary individuals except when mating or when a mother has young, usually fighting to the death if two are put together.

Pocket gophers do not hibernate and, when burrowing under snow, they deposit the excavated earth in abandoned snow tunnels. The earth cores become visible when the snow thaws.

There is one litter per year born in late spring or early summer. Litter size averages 5 or 6 but may range from one to more than a dozen. Dispersal of the young is often done above ground in late summer or early fall. The population turnover rate is often 70-80% per year due to natural causes.

Pocket gophers feed on a great variety of forbs, grasses, seeds, acorns, tubers, bulbs, roots, bark of trees, and when protected by snow, they gnaw on branches and main stems of conifers several feet above ground.

The most practical method of controlling large numbers of gophers is to place toxic baits underground by hand probing or by use of a mechanical burrow builder. Of the rodenticides that are readily available, strychnine alkaloid is the most effective toxicant. For cleanup work or for small areas where only a few animals are involved, trapping is an effective means of control. Fumigation is generally unsatisfactory because of the extent of the burrow system and the fact that gophers may plug off their burrows when the fumigant is detected.

KEY TO MAPS

N.E.E.D. CAMP

1) Dead ponderosa pine with western pine beetle, California flatheaded borer, and red turpentine beetles. Several dead ponderosa pine seedlings in area. True mistletoe on oak. 24" dbh ponderosa pine with decay at base leaning over residence.

2) White trunk rot in black locust.

3) Oak over main building; slight lean away from building; no decay in base.

4) Large oak forked at base; decay in base, possibly armillaria root rot; large branches over building; examine for hazard potential.

5) Black locust with dead branches hanging over amphitheater.

6) 18" dbh ponderosa pine with heavy pitch flow from bole-cause unknown; fire scar on side facing pond.

7) 12" dbh oak with butt hollow; could brush cabin #6.

8) Leaning 12" dbh oak behind cabin #7.

9) Oak with hollow butt behind restroom.

10) 2 oaks with some decay but no permanent target to constitute a hazard.

11) 18" dbh live oak with decay at base, large limbs over cabin, leaning over cabin.

12) Pocket gopher mounds in playing field.

13) True mistletoe in oak.

14) Sequoia pitch moth associated with pruning in ponderosa pine.

15) Planted ponderosa pines may need thinning.

Tower House

1) 2 dead incense-cedars.

2) Group of dead hardwoods.

3) 3 dead Douglas-firs along fence; no evidence of pathogens.

4) Willow with branch split out near water tank.

5) Pocket gopher mounds in yard.

Oak Bottom Recreation Area

1) Dead knobcone pine.

2) Dead knobcone pine and dead manzanita next to power pole.

3) Area of knobcone pine that needs to be thinned.

4) Group of dead knobcone pines with pine engraver and red turpentine beetles.

5) Area of manzanita with branch and twig dieback.

6) Dead 12" dbh knobcone pine along trail with California flatheaded borer.

7) Dead knobcone pine with California flatheaded borer.

8) Several dead knobcone pines with California flatheaded borer.

9) Dead knobcone pine with California flatheaded borer.

Dry Creek Group Camping Area

1) Dead oak branch hanging over comfort station.

2) Dwarf mistletoe on knobcone and ponderosa pine.

Brandy Creek Recreation Area

1) Dead knobcone pine, leaning toward trailer, California flatheaded borers under bark; dead knobcone pine sapling within 10 feet; Annosus root disease center.

2) 20" dbh knobcone pine with Phellinus pini conks from base up to 20 feet; 2 wounds on bole from falling tree; leans toward lake; no permanent target; sounds hollow.

3) Knobcone pine snag next to path from Marina; top could snap and injure passerby.

4) Dead knobcone pine with some flathead activity.

5) True mistletoe in black oak.

6) 2 older dead, 1 recent dead knobcone pines; 1 knobcone pine with branch flagging.

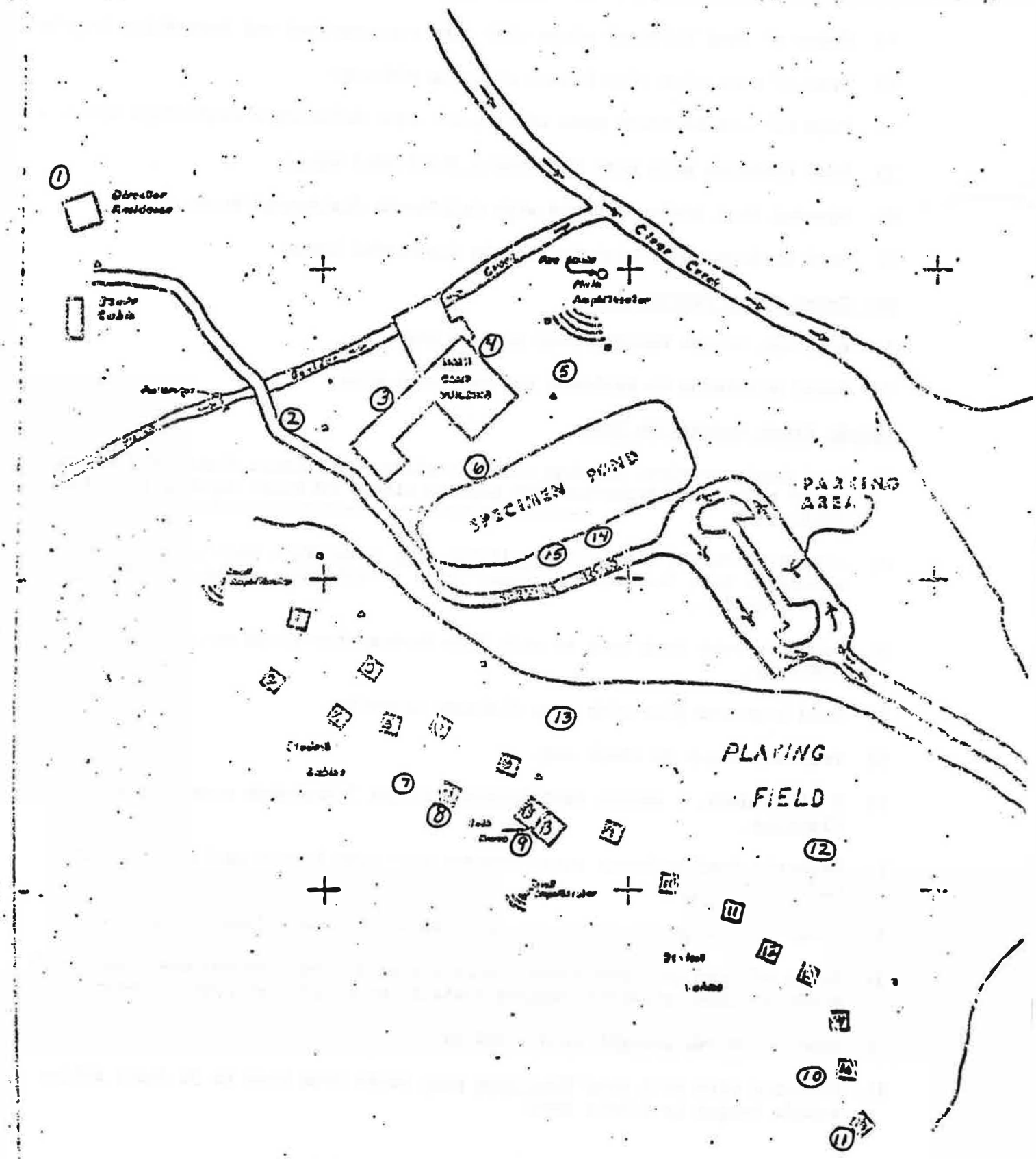
7) Recently dead knobcone pine; western gall rust branch galls on knobcone pine in vicinity.

8) Older dead knobcone pine; top could break out and endanger roadway.

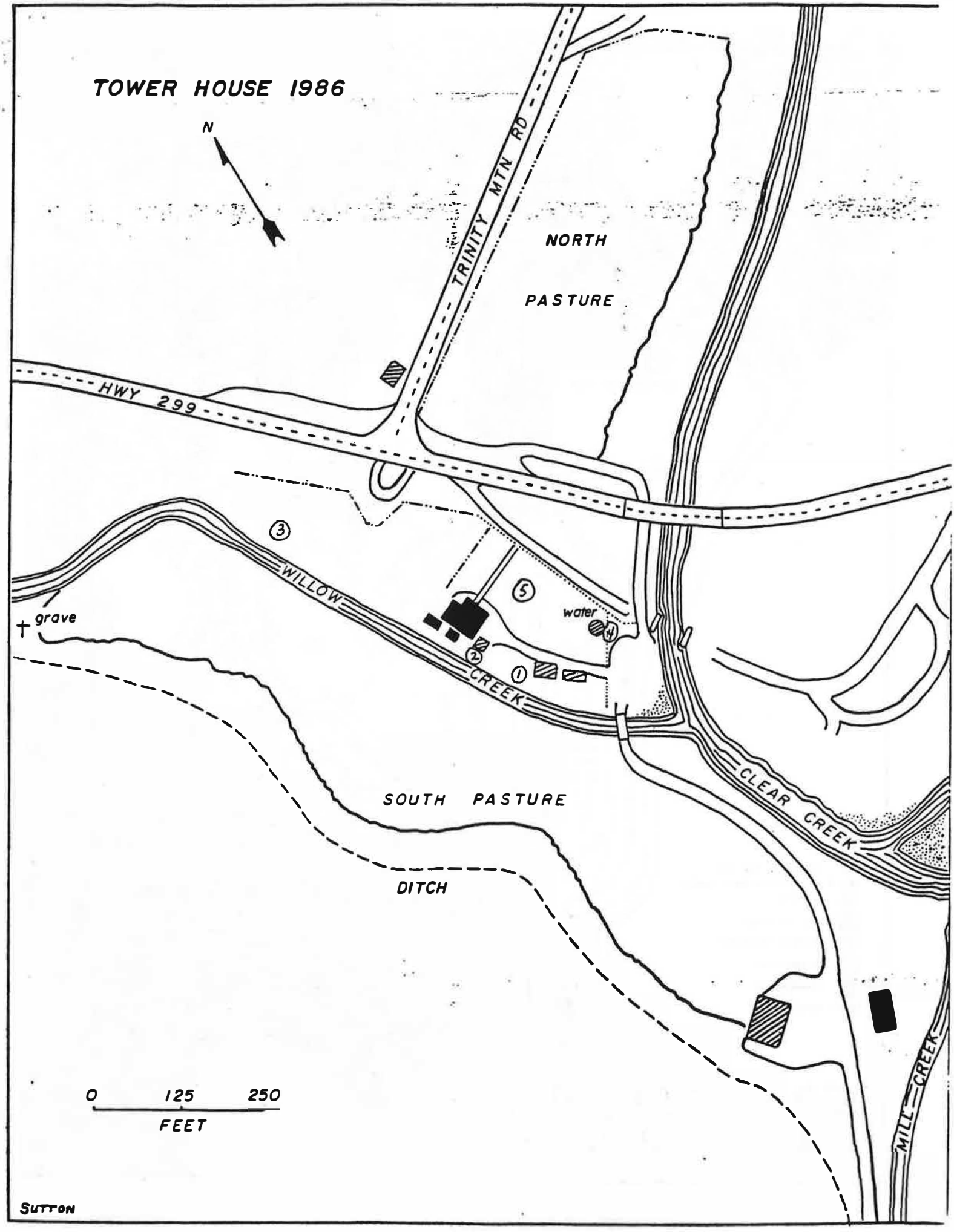
9) Group of dead knobcone pines, including older dead, recent dead, dead with green foliage; previous logging activity on slope over past 10 years.

10) Dead black oak amongst picnic tables.

11) Knobcone pine with many Phellinus pini conks from base to 30 feet; hollow sound; target is picnic area.

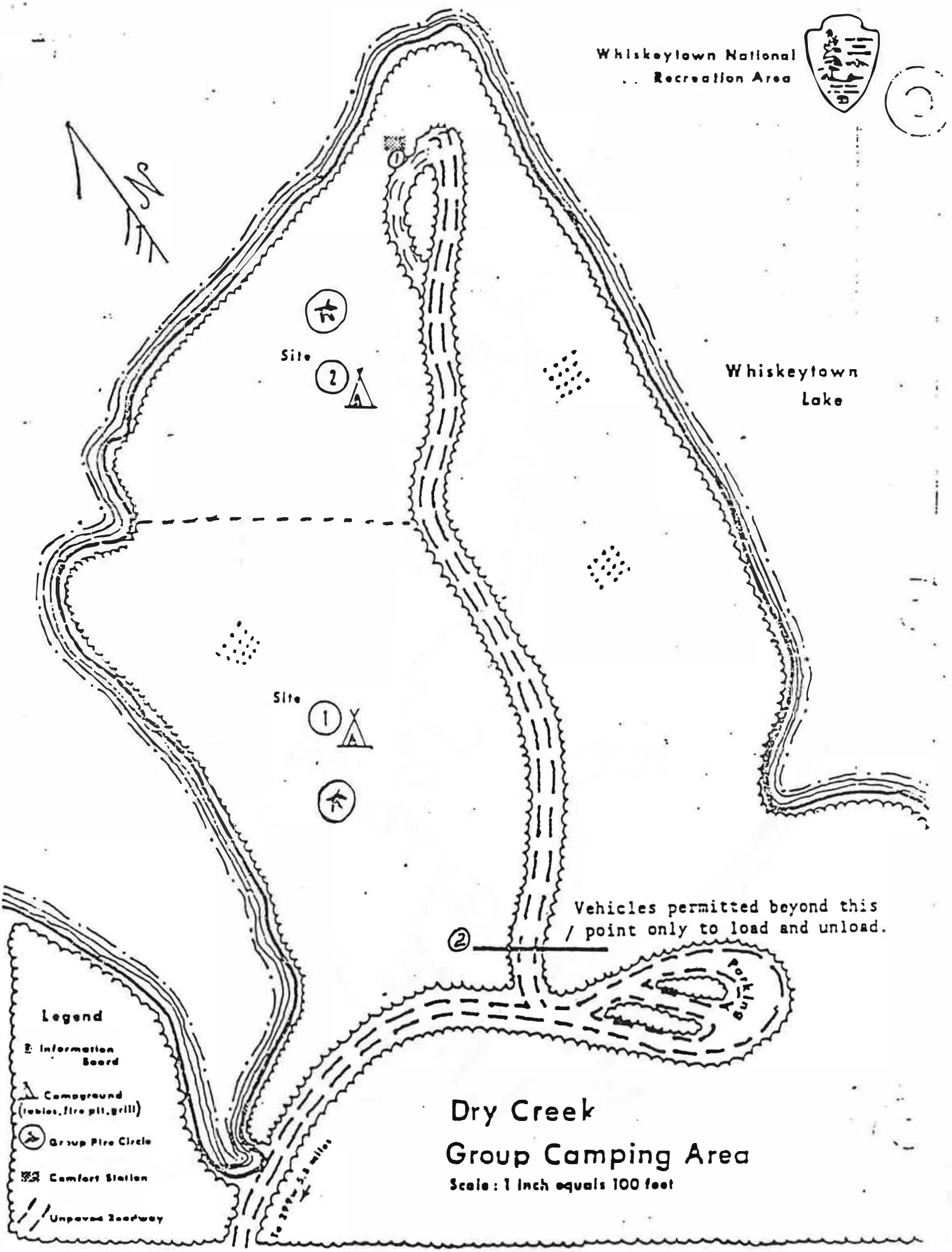


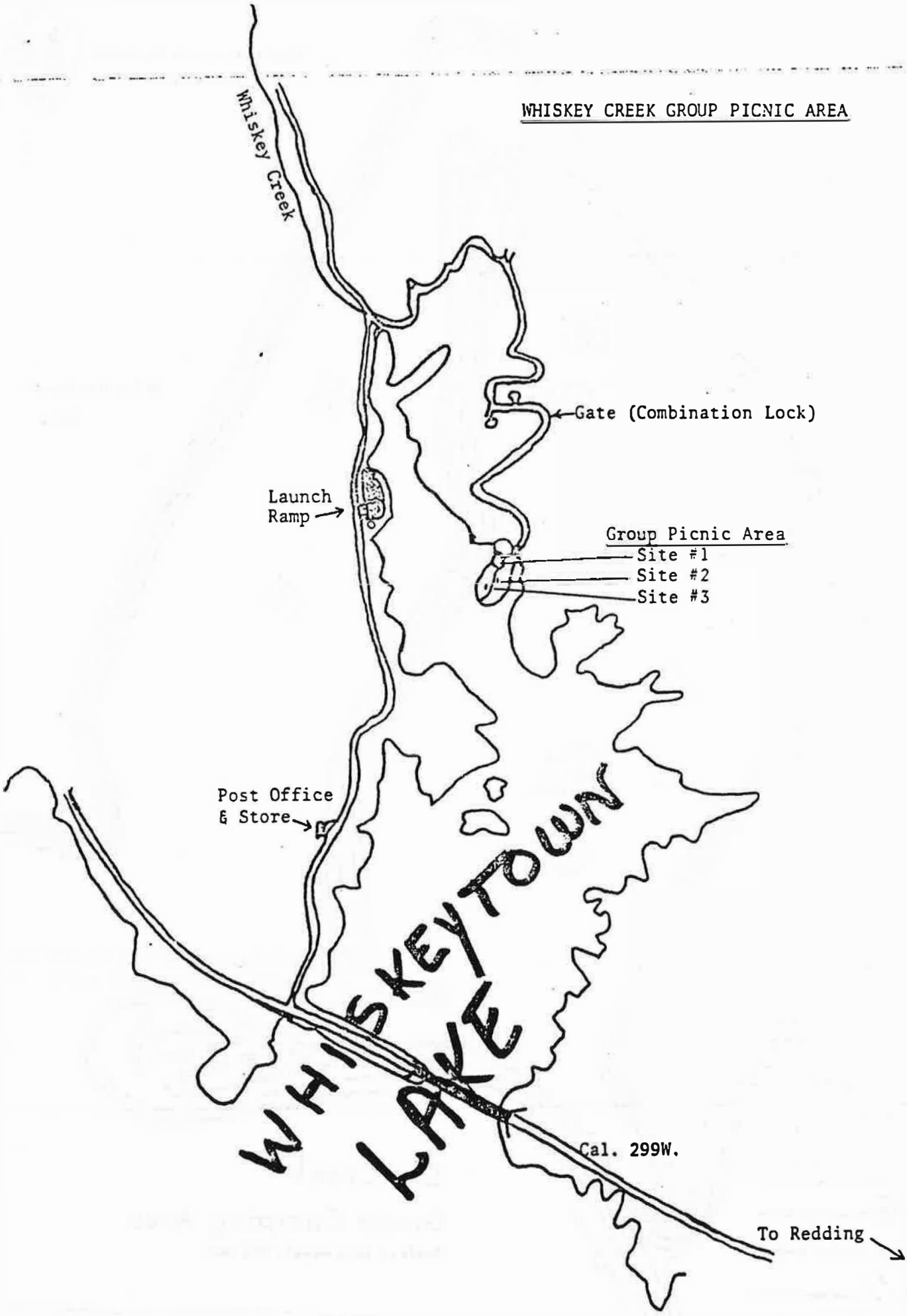
CLEAR CREEK
NATURE CAMP

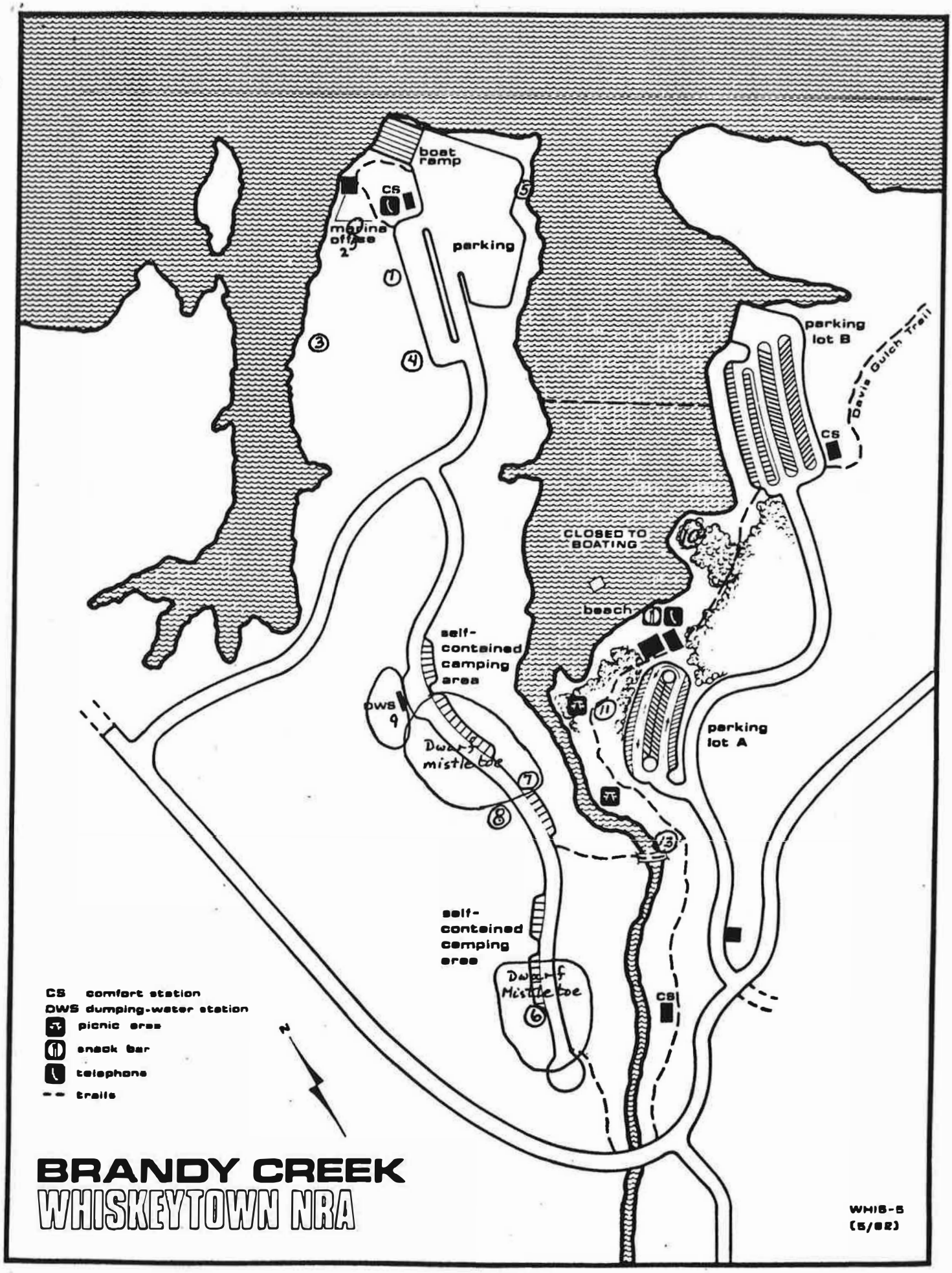

TOWER HOUSE 1986
N
TRINITY MTN RD
NORTH
PASTURE
HWY 299
WILLOW
CREEK
grave
water
SOUTH PASTURE
CLEAR CREEK
DITCH
MILL CREEK
0 125 250
FEET
SUTTON

amphitheater
beach
boat ramp
CS
OWS
comfort station
dumping-water station
marina
picnic area
ranger station
snack bar
telephone
trails
OAK BOTTOM
WHISKEYTOWN NRA

5/87


Whiskeytown National
Recreation Area
N
Site 2
Site 1
Whiskeytown
Lake
Vehicles permitted beyond this
point only to load and unload.
Parking
Legend
Information Board
Campground (tables, fire pit, grill)
Group Fire Circle
Comfort Station
Unpaved Roadway
Dry Creek
Group Camping Area
Scale: 1 inch equals 100 feet


WHISKEY CREEK GROUP PICNIC AREA
Whiskey Creek
Gate (Combination Lock)
Launch Ramp
Group Picnic Area
Site #1
Site #2
Site #3
Post Office & Store
WHISKEYTOWN LAKE
Cal. 299W.
To Redding


boat ramp
CS
marina office
parking
parking lot B
Devils Gulch Trail
CS
CLOSED TO BOATING
beach
self-contained camping area
DWS
Dwarf mistletoe
parking lot A
self-contained camping area
Dwarf Mistletoe
CS
CS comfort station
DWS dumping-water station
picnic area
snack bar
telephone
trails
N
BRANDY CREEK
WHISKEYTOWN NRA
WHIS-5
(5/82)